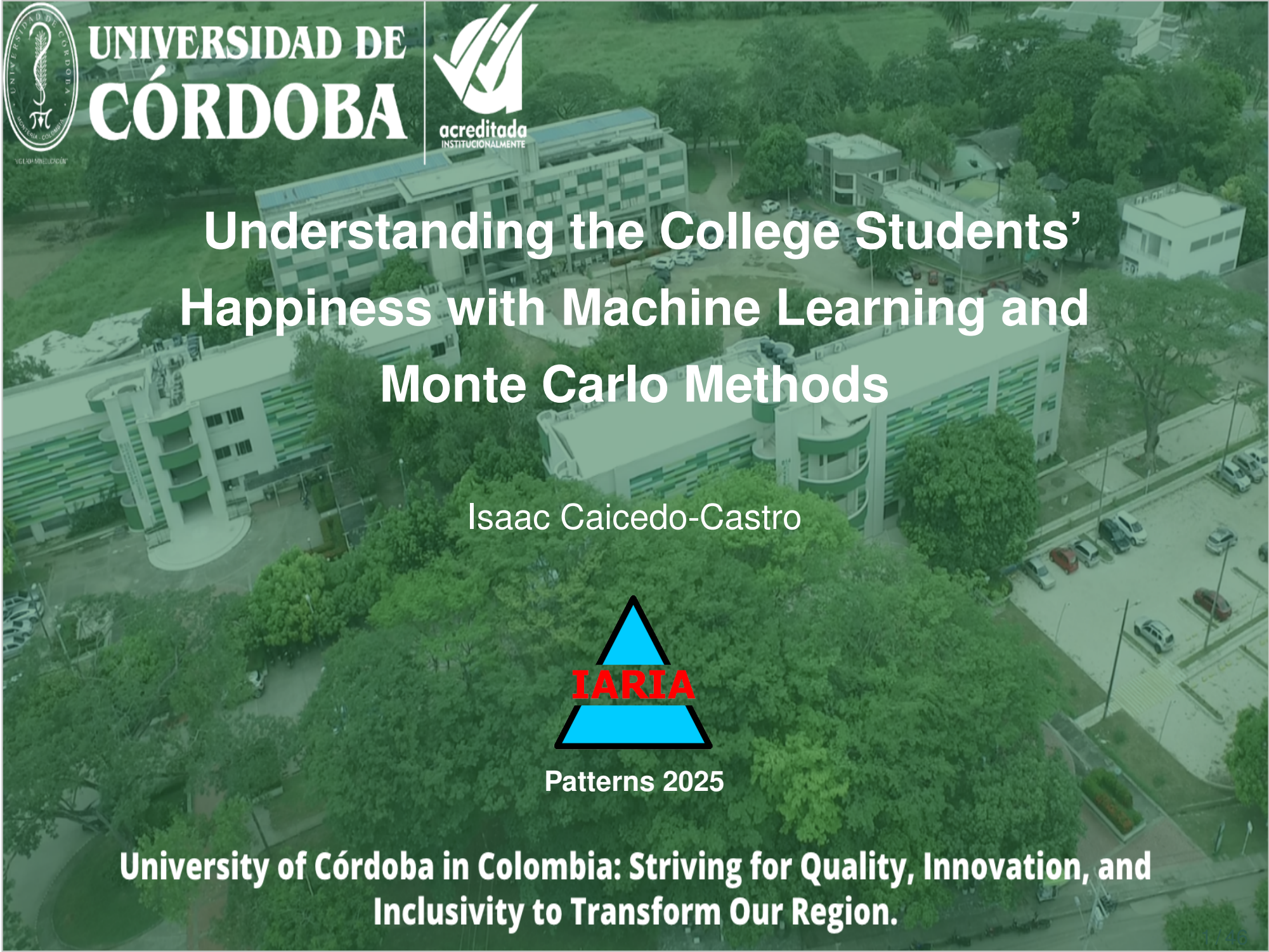

Understanding the College Students' Happiness with Machine Learning and Monte Carlo Methods

Isaac Caicedo-Castro

IARIA

Patterns 2025

University of Córdoba in Colombia: Striving for Quality, Innovation, and Inclusivity to Transform Our Region.

Who am I?

- Isaac Caicedo-Castro
- Full Professor in the Department of Systems Engineering at the University of Córdoba in Colombia
- Ph.D. in Informatics - University of Grenoble Alpes in France
- Ph.D. in Systems and Computing Engineering - National University of Colombia
- Corresponding author: **isacaic@correo.unicordoba.edu.co**

Agenda

Introduction

The Research Methodology

The Research Results

Analysis of The Results

Summary and Conclusions

Question and Answer Session

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- Have you ever paused and asked yourself, “Am I happy?”

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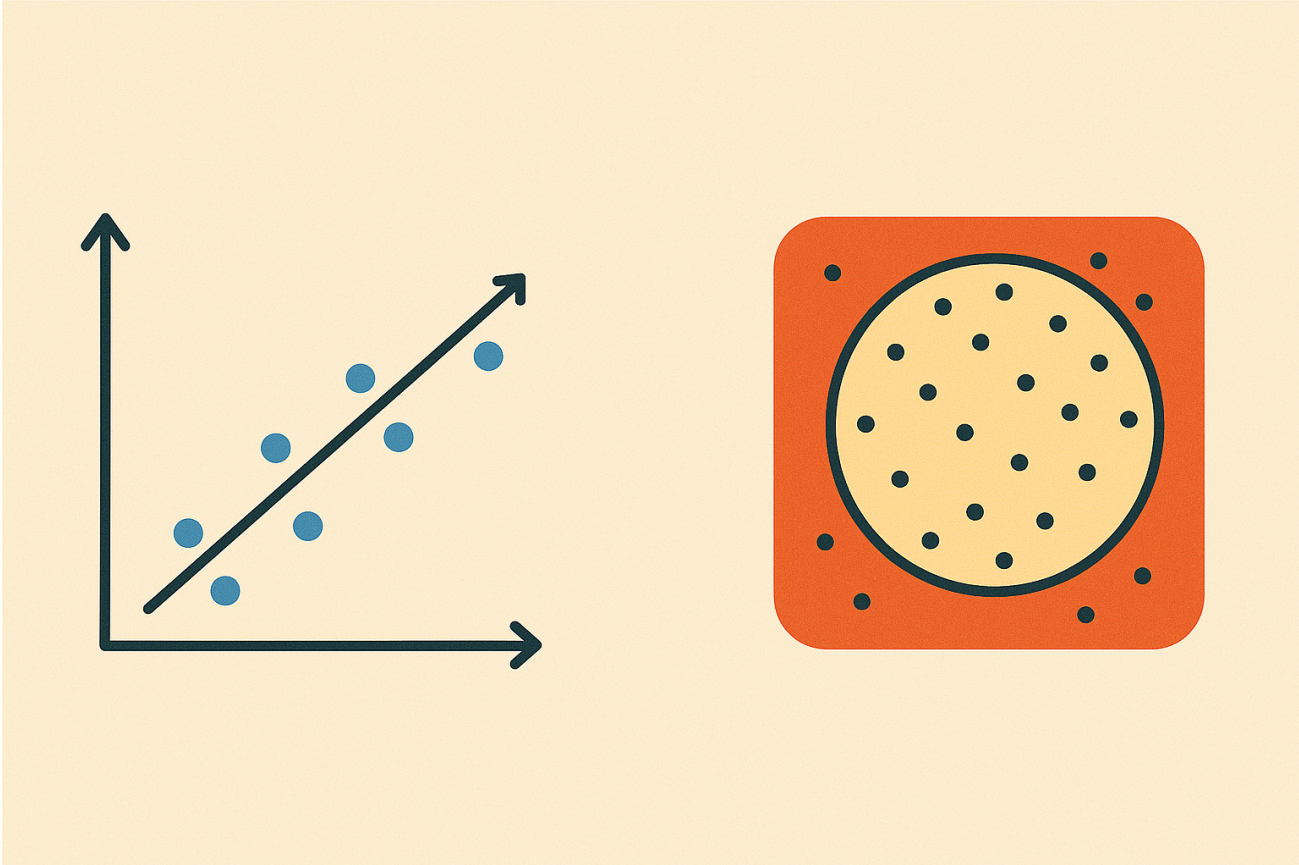

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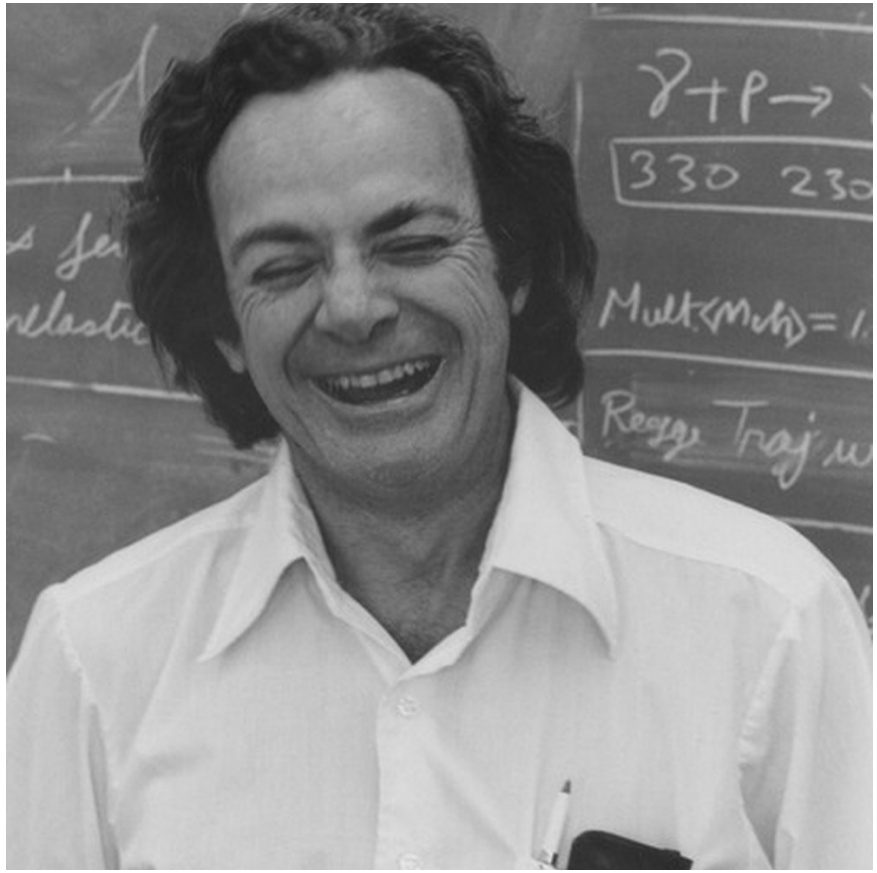

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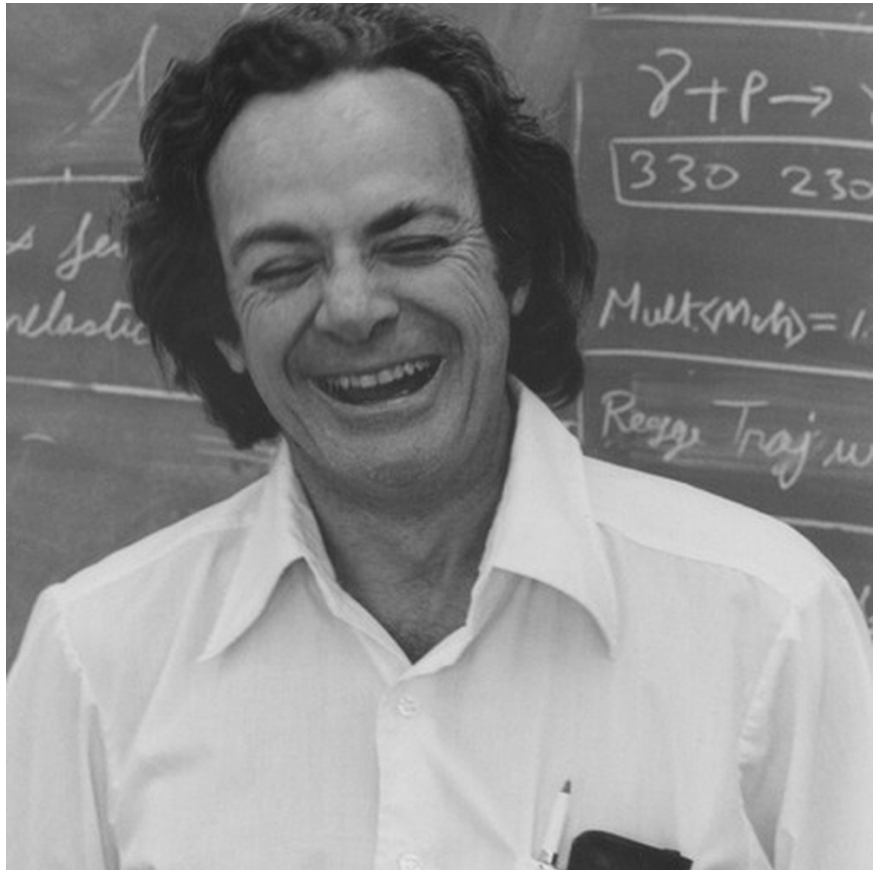

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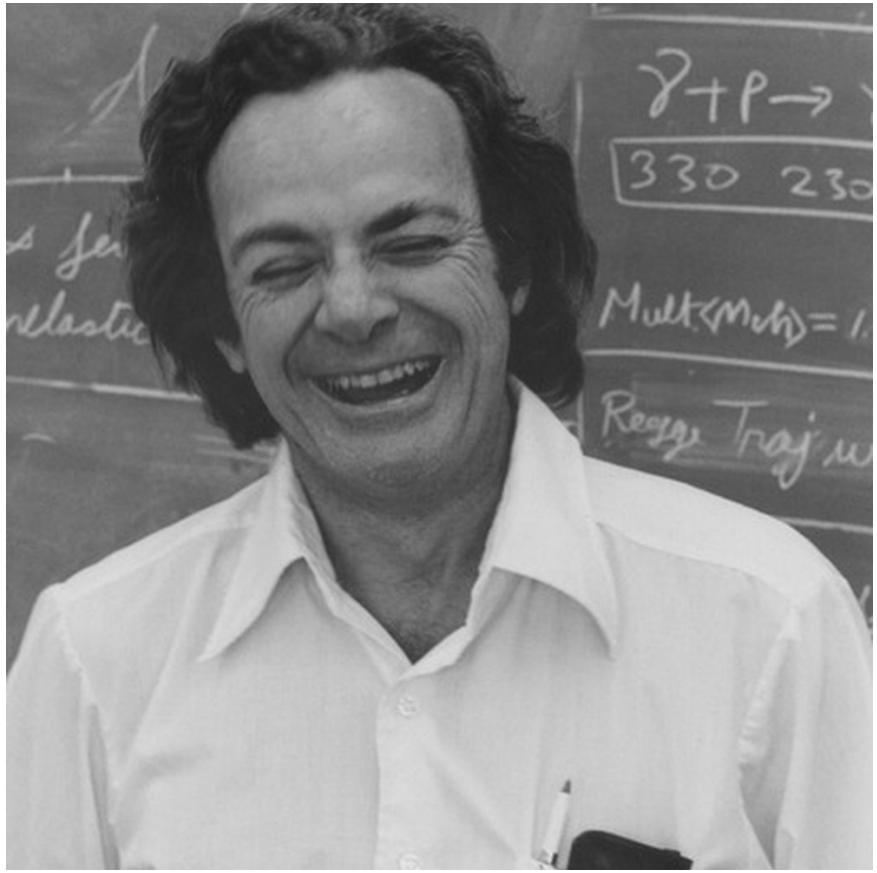

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- Happiness is the foundation of a better life and a goal that people pursue [Jiang et al., 2022]

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- Odds ratio – Monte Carlo method

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Which factors or independent variables are considered in the survey? 1/2

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7. Confidence in solving real-world problems – computer programming, mathematics, and physics – (Likert scale - from 1 to 5) – $x_{i,4} \in [0, 1]$

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Which factors or independent variables are considered in the survey? 2/2

8. Passion for pursuing a degree in systems engineering (Likert scale - from 1 to 5) – $x_{i,5} \in [0, 1]$

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$x_i \in \mathcal{X} \subset \mathbb{R}^D$, $D = 9$

The Research Methodology

Target variable or dependent variable $\rightarrow$ Happiness – 10 levels – Cantril ladder [Helliwell et al., 2025]

$y_i \in \mathcal{Y}$, where $\mathcal{Y} = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\} = [1, 10] \cap \mathbb{N}$

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$$y = [y_1 \ \ldots \ y_i \ \ldots \ y_N]^T, X \in \mathbb{R}^{N \times (D+1)}, w \in \mathbb{R}^{D+1}, y \in \mathbb{R}^N$$

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$$X = \begin{bmatrix} 1 & x_{11} & x_{12} & \ldots & x_{1D} \\ 1 & x_{21} & x_{22} & \ldots & x_{2D} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & x_{i1} & x_{i2} & \ldots & x_{iD} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & x_{N1} & x_{N2} & \ldots & x_{ND} \end{bmatrix} = \begin{bmatrix} 1 & x_1^T \\ 1 & x_2^T \\ \vdots & \vdots \\ 1 & x_i^T \\ \vdots & \vdots \\ 1 & x_N^T \end{bmatrix}, w = [w_0 \ \ldots \ w_D]^T,$$

$$y = [y_1 \ \ldots \ y_i \ \ldots \ y_N]^T, X \in \mathbb{R}^{N \times (D+1)}, w \in \mathbb{R}^{D+1}, y \in \mathbb{R}^N$$

$$\min_w ||Xw - y||^2 + \lambda ||x||^2$$

The Research Methodology

- Given $\mathcal{D} = \{(x_i, y_i) | x_i \in \mathcal{X}, y_i \in \mathcal{Y}, \text{for } i = 1, \ldots, N\}$
- $g : \mathcal{X} \to \mathcal{Y}$
- $g(x_i) \approx y_i$
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$$y = [y_1 \ \ldots \ y_i \ \ldots \ y_N]^T, X \in \mathbb{R}^{N \times (D+1)}, w \in \mathbb{R}^{D+1}, y \in \mathbb{R}^N$$

$$\min_w ||Xw - y||^2 + \lambda ||x||^2 \implies w = (X^T X + \lambda I)^{-1} X^T y$$

The Research Methodology

- 10-Fold Cross-Validation $\rightarrow \mathcal{D}$ ($N = 134$) $\rightarrow \lambda$

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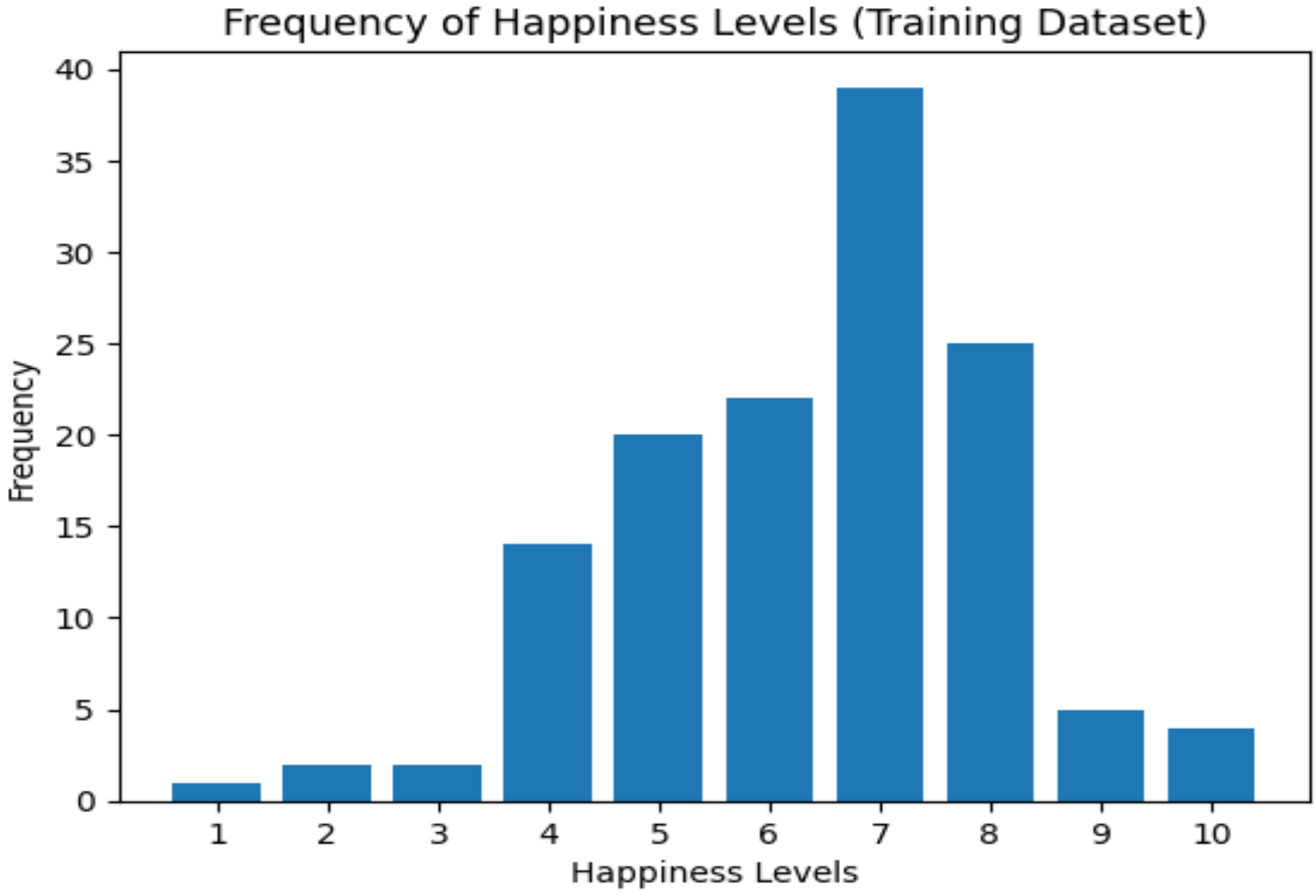
-

$$OR(y_i | x_{ij}) = \frac{\frac{P(y_i > 5 | x_{ij} \geq 0.7)}{1 - P(y_i > 5 | x_{ij} \geq 0.7)}}{\frac{P(y_i > 5 | x_{ij} \leq 0.3)}{1 - P(y_i > 5 | x_{ij} \leq 0.3)}},$$ OR stands for Odds Ratio

Agenda

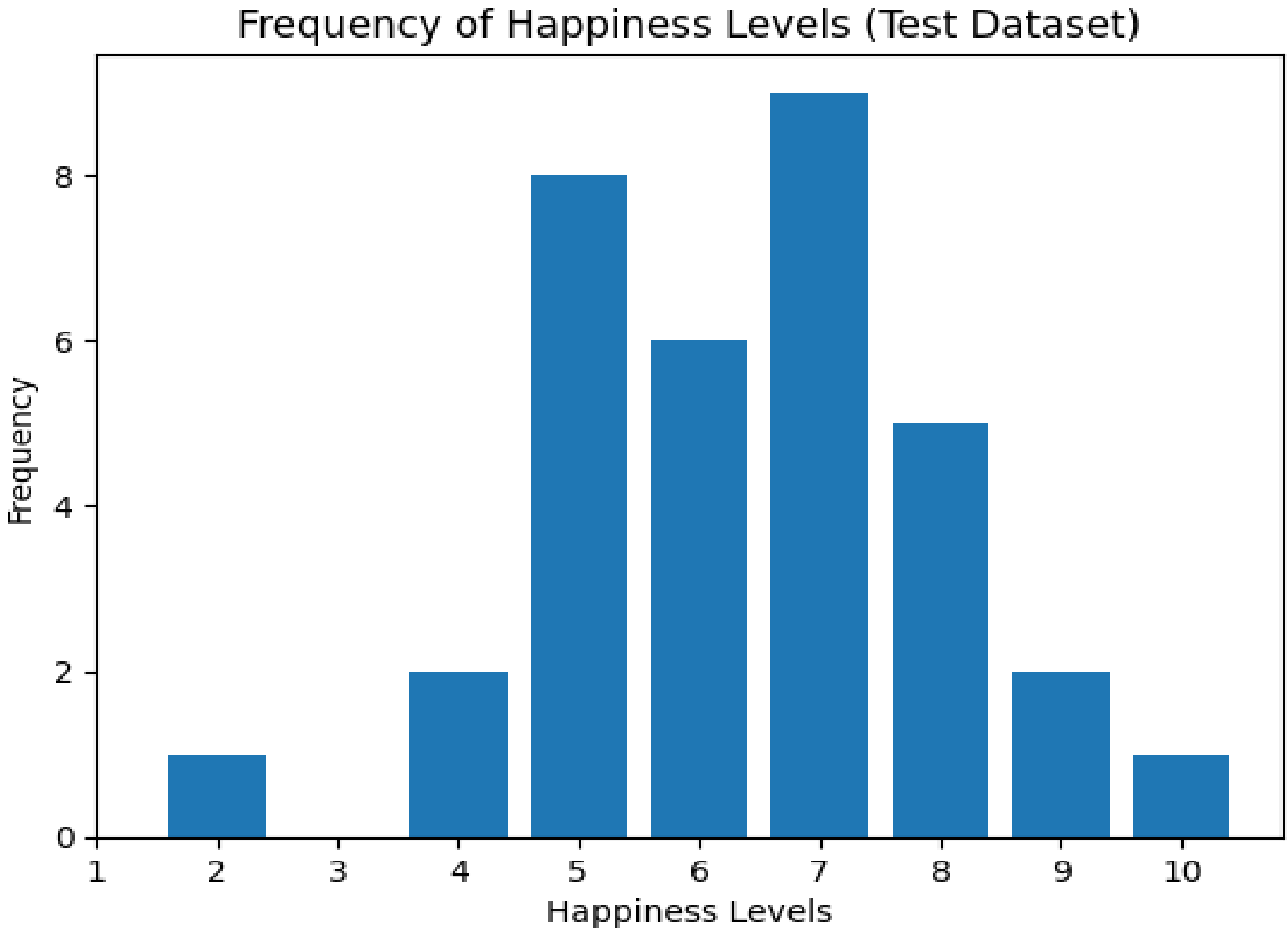
The Research Results

Students' Happiness in the Dataset for 10-Fold Cross-Validation



The Research Results

Students' Happiness in the Dataset Enshrined in the Test

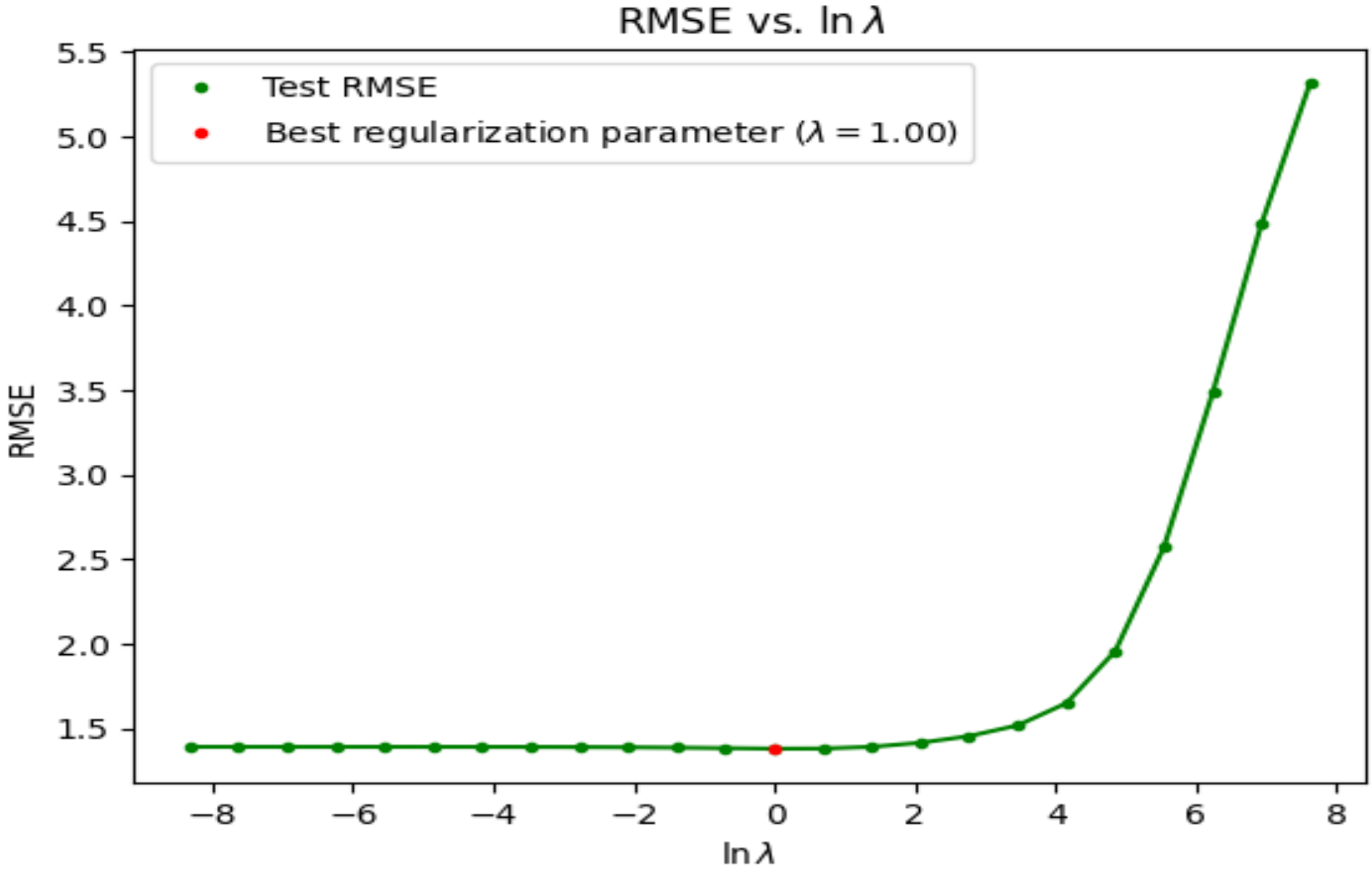


The Research Results

10-Fold Cross-Validation Outcome

Best Average RMSE: 1.3807

Best Mean of R^2: 0.2332



The Research Results

Test Outcome
RMSE: 1.09
R^2: 0.56

$$g(x_i) = 3.27 + 0.97x_{i1} + 0.07x_{i2} + 0.87x_{i3} + 0.79x_{i4} + \ldots$$

$$\cdots + 0.83x_{i5} + 0.12x_{i6} - 1.08x_{i7} + 1.43x_{i8} + 1.06x_{i9}$$

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Satisfaction with quality of lecturers (x_{i8}) and an adequate learning environment with up-to-date resources (x_{i9}) strongly influence the student happiness.

The Research Results

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Financial concerns (x_{i7}) negatively influences the student happiness.

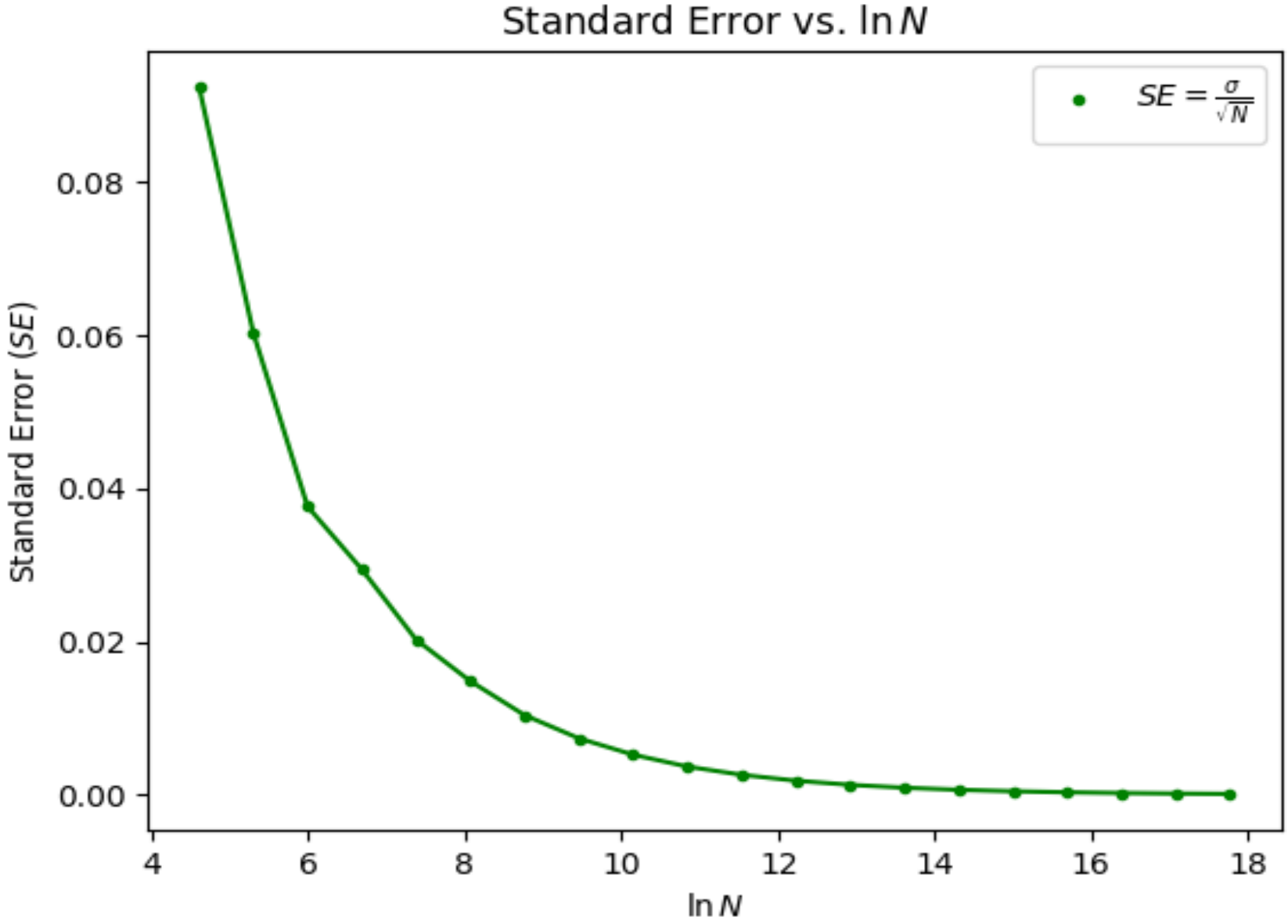
The Research Results

Monte Carlo Simulation Outcomes

- N = 52428800
- Expected Level: $\bar{y} = 5.80118$
- Standard Error 0.00012
- $\bar{y}$ is within (5.80096, 5.80141)
- with 95% (alpha = 0.05) confidence interval

The Research Results

Monte Carlo Simulation Outcomes



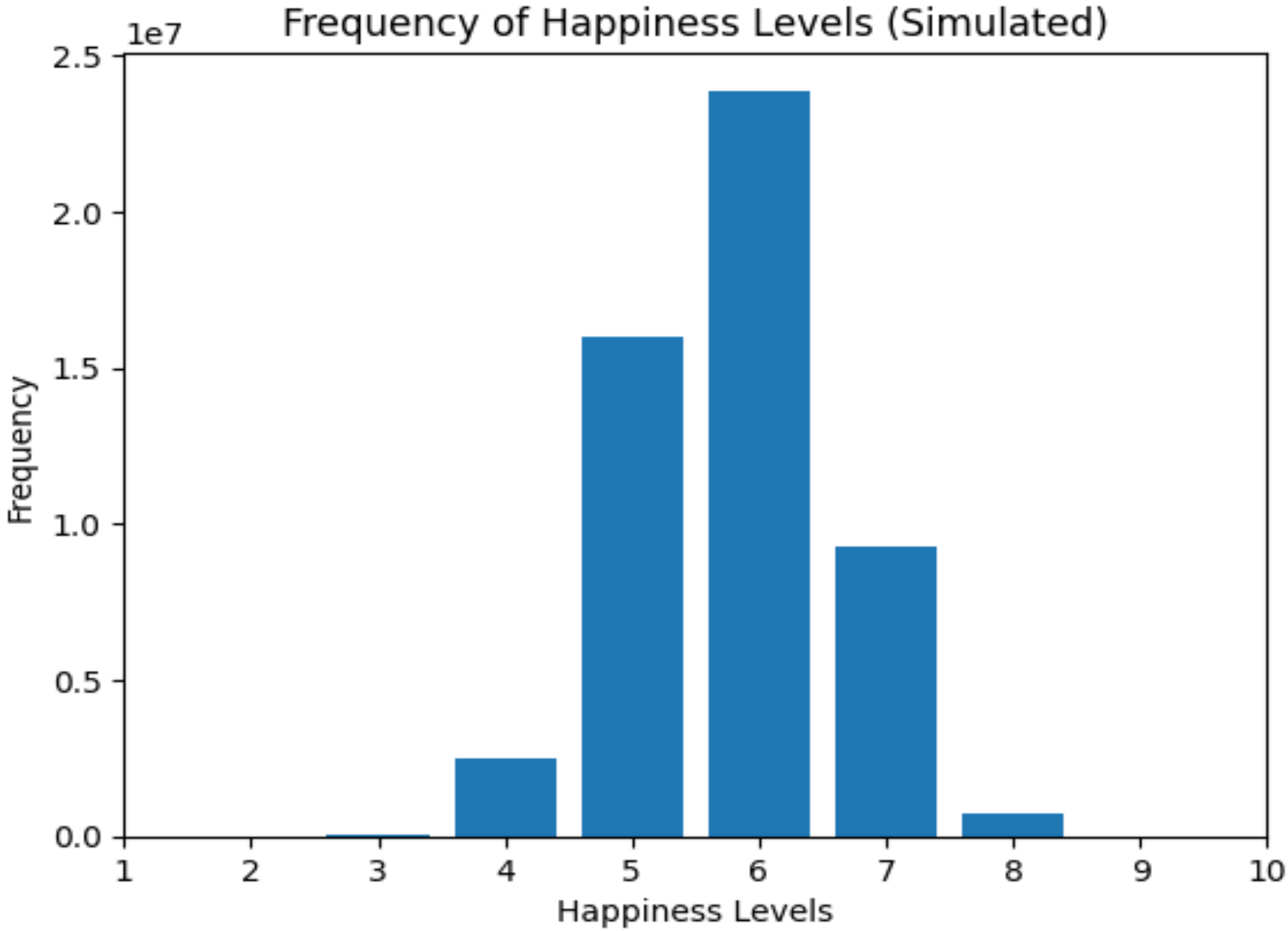
The Research Results

Monte Carlo Simulation Outcomes

Level	*Probability*
3	$P(y = 3) = 8.57 \times 10^{-2}\%$
4	$P(y = 4) = 4.75\%$
5	$P(y = 5) = 30.53\%$
6	$P(y = 6) = 45.56\%$
7	$P(y = 7) = 17.71\%$
8	$P(y = 8) = 1.34\%$
9	$P(y = 9) = 5.29 \times 10^{-3}\%$

The Research Results

Monte Carlo Simulation Outcomes



The Research Results

Monte Carlo Simulation – p-value < 0.05 (Wald test)

Factor	*Odds ratio – 95% CI*
Confidence in securing a job after graduation	4.37 – CI [1.473, 1.476]
Meeting with an academic advisor	1.1 – CI [0.093, 0.096]
Peer support	3.73 – CI [1.314, 1.317]
Confidence in solving real-world problems	3.24 – CI [1.173, 1.176]
Passion for pursuing the bachelor's degree	3.45 – CI [1.238, 1.241]
Motivation to excel in studies	1.18 – CI [0.167, 0.170]
Financial concerns	0.19 – CI [-1.678, -1.675]
Satisfaction with the quality of lectures	11.37 – CI [2.429, 2.433]
Up-to-date resources	5.22 – CI [1.652, 1.655]

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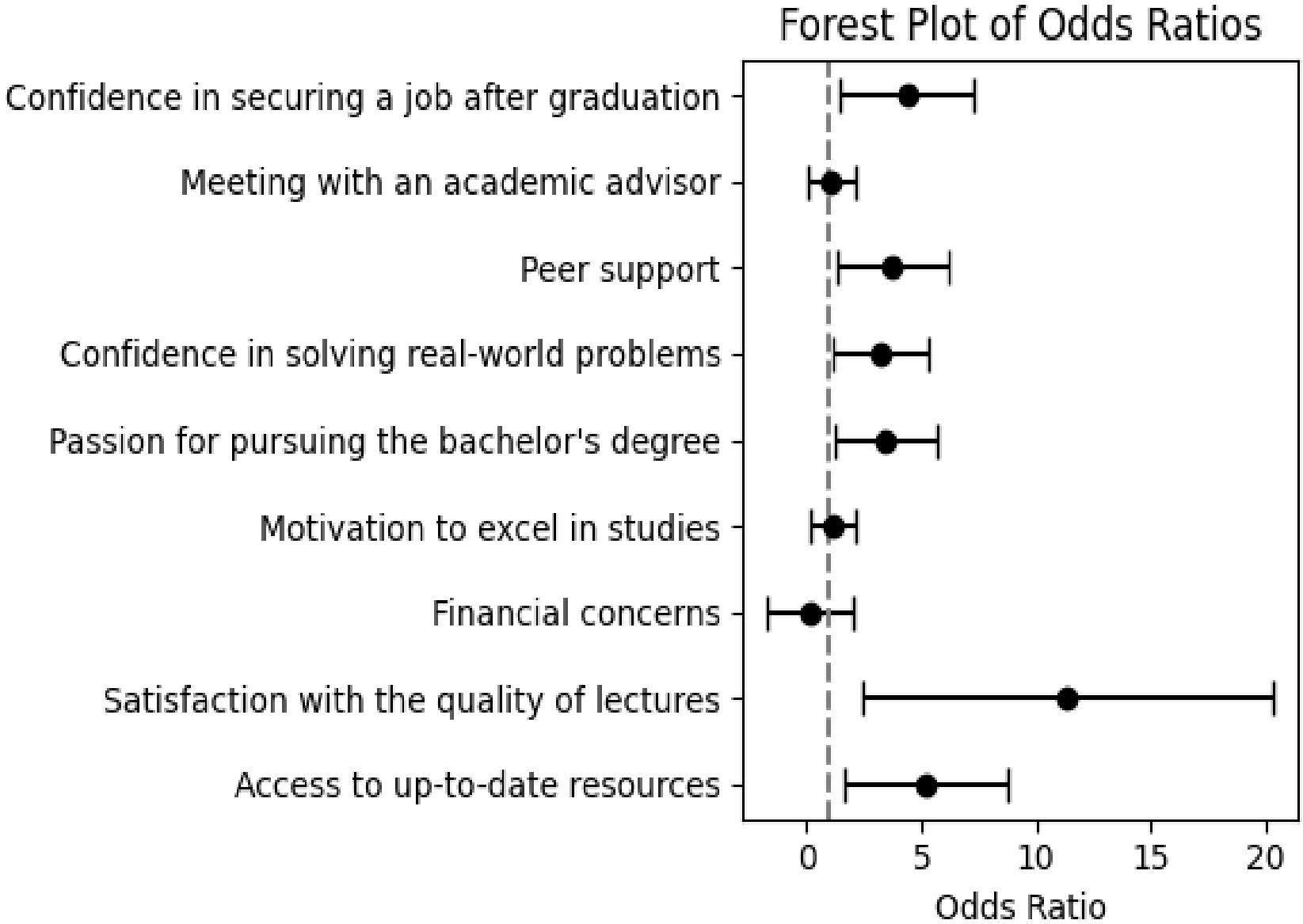

Agenda

Analysis of The Results

Strong influence of lecturer quality

- ☺ with the quality of lecturers $\rightarrow$ importance of Social Support [Zhou and Lin, 2016]

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- Lecturers $\rightarrow$ positive, engaging, and supportive learning environment
- Empathetic lecturers $\rightarrow$ hope about student future
- Poor lectures $\rightarrow$ confusion $\propto$ Stress and Anxiety
- High-quality instruction $\rightarrow$ time, money, and effort are well spent

Analysis of The Results

Strategies

- Continuous development for lecturers

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- Constructive feedback

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- Promote student-lecturer interaction

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- Continuous development for lecturers
- Constructive feedback
- Promote student-lecturer interaction
- Align lessons with student needs
- Reward teaching excellence

Analysis of The Results

Up-to-date resources is key

- Boosts motivation

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- Fosters Engaging Classroom Discussions

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Up-to-date resources is key

- Boosts motivation
- Perception of quality
- Better learning outcomes $\rightarrow$ less stress
- Fosters Engaging Classroom Discussions
- Aligns with Tech-Savvy Expectations

Analysis of The Results

Strategies

- Staff and lecturers $\rightarrow$ visuals, videos, lecture notes, books, etc.

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- Good illumination and environmental temperature control in classrooms

Analysis of The Results

Strategies

- Staff and lecturers $\rightarrow$ visuals, videos, lecture notes, books, etc.
- Decent facilities
- Sport fields and gyms
- Good illumination and environmental temperature control in classrooms
- Access to the cloud, and good power computing (perhaps to a quantum computer)

Analysis of The Results

Confidence in securing a job after graduation

- Sense of security, purpose, and future well-being

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- Endeavor $\rightarrow$ somewhere meaningful, not a risk but investment

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- Endeavor $\rightarrow$ somewhere meaningful, not a risk but investment
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- Enhanced self-esteem

Analysis of The Results

Confidence in securing a job after graduation

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- Endeavor $\rightarrow$ somewhere meaningful, not a risk but investment
- Reduced uncertainty
- Increased motivation and engagement
- Enhanced self-esteem
- Perceived financial stability

Analysis of The Results

Confidence in securing a job after graduation

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- Reduced uncertainty
- Increased motivation and engagement
- Enhanced self-esteem
- Perceived financial stability
- Social comparison and cultural pressures

Analysis of The Results

Strategies

- Introduce career planning $\rightarrow$ beginning

Analysis of The Results

Strategies

- Introduce career planning $\rightarrow$ beginning
- Information $\rightarrow$ employment trends, salary expectations, and growth sectors

Analysis of The Results

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- Project-based learning or case studies $\rightarrow$ communication, problem-solving, teamwork, digital literacy

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- Introduce career planning $\rightarrow$ beginning
- Information $\rightarrow$ employment trends, salary expectations, and growth sectors
- Internships $\rightarrow$ part of the curriculum
- Project-based learning or case studies $\rightarrow$ communication, problem-solving, teamwork, digital literacy
- Teach students $\rightarrow$ professional platforms (e.g., LinkedIn)

Analysis of The Results

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- Mental health (e.g., chronic anxiety and depression)

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- Fear about the future

Analysis of The Results

- Financial concerns
- Mental health (e.g., chronic anxiety and depression)
- Sleep quality
- Concentration and performance
- Cognitive burden and distraction
- Less time for social life and self-care (e.g., rest, exercise, etc.)
- Reduce academic opportunities
- Fear about the future
- Cause dropouts or delay graduation

Analysis of The Results

Strategies $\rightarrow$ University of Córdoba

- Waiver of the enrollment fee $\rightarrow$ undergraduate programs

Analysis of The Results

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- Waiver of the enrollment fee $\rightarrow$ undergraduate programs
- Grants $\rightarrow$ student research
- Mental health and counseling service $\rightarrow$ well-being department
- Library $\rightarrow$ online and printed literature

Analysis of The Results

Strategies $\rightarrow$ University of Córdoba

- Waiver of the enrollment fee $\rightarrow$ undergraduate programs
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- Mental health and counseling service $\rightarrow$ well-being department
- Library $\rightarrow$ online and printed literature
- Agreements $\rightarrow$ public transportation service

Agenda

Summary and Conclusions

Satisfaction with the quality of lectures – OR = 11.37 – $w_8 = 1.43$

Summary and Conclusions

Up-to-date resources – OR = 5.22 – $w_9 = 1.06$

Summary and Conclusions

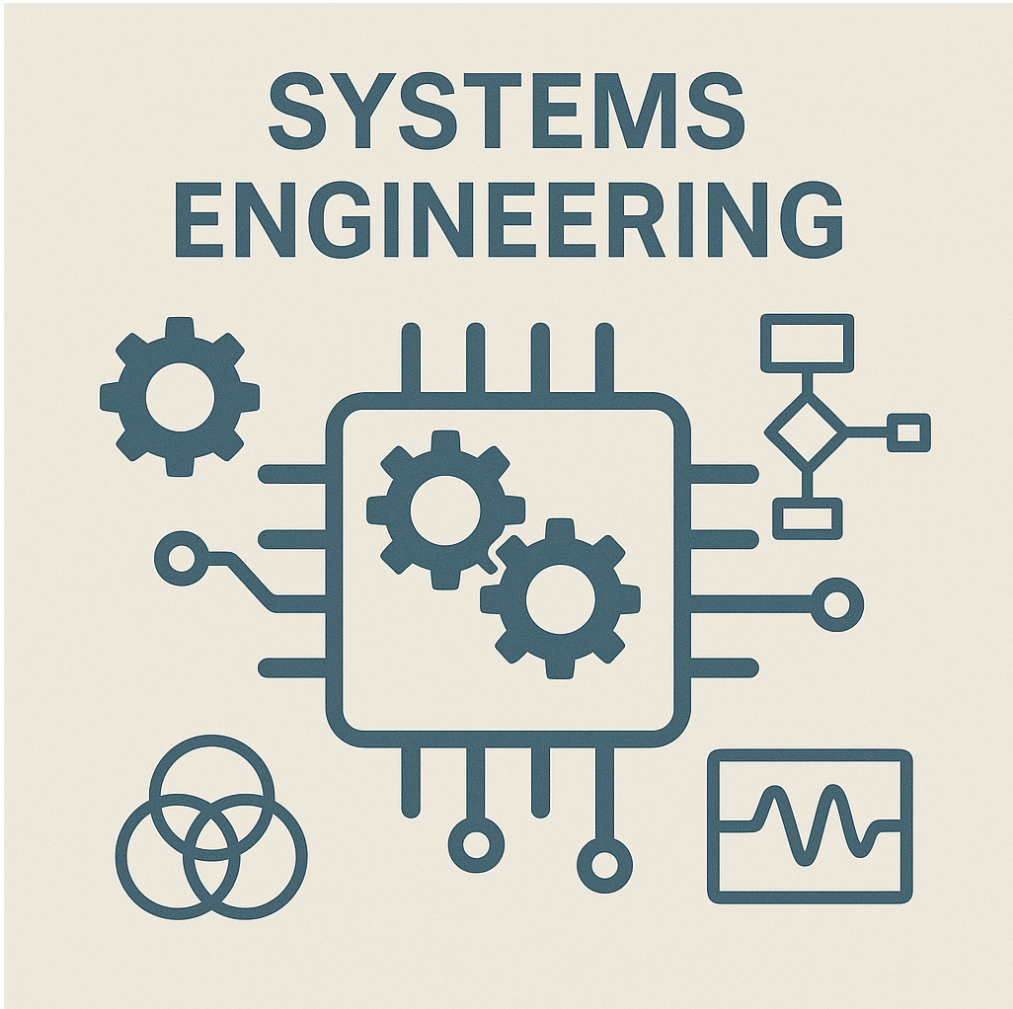
Confidence in securing a job after graduation – OR = 4.37 – $w_1 = 0.97$

Summary and Conclusions

Peer support – OR = 3.73 – $w_3 = 0.87$

Summary and Conclusions

Passion for pursuing the bachelor's degree in Systems Engineering – OR = 3.45– $w_5 =$



Summary and Conclusions

Confidence in solving real-world problems – OR = 3.24 – $w_4 = 0.79$

Summary and Conclusions

Motivation to excel in studies– OR = 1.18 – $w_6 = 0.12$

Summary and Conclusions

Meeting with an academic advisor – OR = 1.1– $w_2 = 0.07$

Summary and Conclusions

Financial concerns – OR = 0.19 – $w_7 = -1.08$

Summary and Conclusions

Directions for further research:

- Collect more data (other B.Sc. programs)

Summary and Conclusions

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- Analyze the latent factors that explain the observable variables

Summary and Conclusions

Directions for further research:

- Collect more data (other B.Sc. programs)
- Study other factors
- Assuming an nonlinear relation among variables
- Create and evaluate a feasible and realistic strategic plan and policies
- Analyze the latent factors that explain the observable variables
- Conduct research to analyze students' social networks

Agenda

Introduction

The Research Methodology

The Research Results

Analysis of The Results

Summary and Conclusions

Question and Answer Session

That’s all folks

Now starts the Q ’n’ A session

Praise the name of God forever and ever, for he has all wisdom and power. He controls the course of world events; he removes kings and sets up other kings. He gives wisdom to the wise and knowledge to the scholars. He reveals deep and mysterious things... (Daniel 2:20-22)

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